

Summary of Applicant's Invention

The Applicant's invention is directed to a method for fabricating a damascene structure. More noticeably, a first chemical mechanical polishing process is performed with a first slurry to remove the metal layer until the barrier layer is exposed. A second chemical mechanical polishing process is further performed with a second slurry and a solution to remove the barrier layer and to adjust the zeta potential of the metal layer during the removal of the barrier layer. By changing the zeta potential of the metal layer, particles are prevented from adhering onto the surface metal layer and to minimize defects formed on the surface of the metal layer.

Response to 35 U.S.C. 103 (a) rejection

Claims 1-17 are rejected under 35 U.S.C. 103(a) as being unpatentable Farkas et al. (U.S. 6,001,730, Farkas hereinafter).

The Office has the burden under section 103 to establish a prima facie case of obviousness. The Office satisfies this burden "only by showing some objective teaching in the prior art or that knowledge generally available to one of ordinary skill in the art would lead that individual to combine the relevant teachings of the references." In re Fine, 837 F.2d 1071, 5 U.S.P.Q. 2d 1596, 1598 (Fed. Cir. 1988). "Moreover, the question is not simply whether the prior art "teaches" the particular element of the invention, but whether it would 'suggest the desirability, and thus the obviousness, of making the combination.'" ALCO Standard Corp. V. Tennessee Valley Authority, 808 F.2d 1490, 1498, 1 U.S.P.Q. 2d 1337, 1343 (Fed. Cir. 1986). Applicants respectfully assert that the aforementioned combination of references is legally

deficient for the purpose of rendering claims 1-17, 21-22 obvious according to the following remarks.

Applicants submit that independent claim 1 and 11 define over the cited references for at least the reason that references do not possess any reason, suggestion or motivation from the prior art as a whole for the person of ordinary skill to modify or combine the references. Further, even there was motivation to combine, the combination of the cited references fails to teach, suggest or disclose at least the emphasized feature. More specifically, claims 1 and 11 require

“...performing a second chemical mechanical polishing process with a second slurry and a solution to remove the barrier layer and adjusting a zeta potential of the metal layer with the solution during the removal of the barrier layer.” The technical impact of the above feature is that by changing the zeta potential of the metal layer, carbon-rich particles, produced during the CMP process if low K-dielectric material is exposed, are prevented from adhering onto the surface of the metal layer. Defects formed on the surface of the metal layer are thus mitigated. Since the low K-dielectric material is likely to be exposed during the removal of the barrier layer, it is thus essential for the instant case that during the removal of the barrier layer, the second slurry that is used to remove the barrier layer includes a solution that also alters the zeta potential of the metal layer. As a result, the carbon-rich particles, generated from the low K dielectric layer underneath the barrier layer, are prevented from adhering onto the surface of the metal layer while the barrier layer is being removed.

Farkas, on the contrary, teaches a two-step or a possible three-step CMP process for forming a copper interconnect that uses a tantalum-based barrier layer. The copper interconnect polish steps of Farkas use particular slurries in conjunction with specific types of polishing pad to

reduce the problem of dishing. The first CMP process of Farkas for removing the metal layer is conducted with a slurry that contains an oxidizing agent (col. 5, lines 43-60). A second CMP process of Farkas for removing the barrier layer is conducted with a slurry that contains silica abrasive and an ethylenediamine additive. Reviewing again col. 7, lines 30-57 of Farkas as suggested by the Office, Farkas in the relevant section stated that the second slurry with an ethylenediamine additive, used in conjunction with a specific polishing pad, the polish rate of TaSiN was 550 angstroms/min, the polish rate of copper was 330 angstroms/min, and the polish rate of silicon oxide was 340 angstroms/min. Farkas further stated in col. 7, lines 62-66, that a sufficiently low copper removal rate (<500 angstroms/min for copper) was achieved in the second CMP step to reduce pitting. Therefore, Applicants are puzzled on how the Office can not concluded that the second CMP process of Farkas with the ethylenediamine additive and a specific polishing pad is to provide a faster polishing rate for the barrier layer. Even though that Farkas's slurry also comprises water, abrasive particles, surfactant, buffer solution, anti-corrosive agent, there is no where in Farkas that either explicitly disclose or implicitly suggest a solution, in addition to the slurry for removing the barrier layer, wherein the zeta potential of the metal layer can be adjusted with the solution during the removal of the barrier layer.

Further, although Farkas further teaches that a third CMP step may be performed after the second CMP step. The third polish step is an oxide polish, for example, a touch up of the oxide (col. 7, lines 10-25) and is not a polish step that comprises an oxidant, which may modify the zeta potential of a metal layer. Additionally, this third polish step is performed subsequent to the barrier layer removal second polish step. The present invention, on the other hand, requires adjusting the zeta potential of the metal layer during the removal of the barrier layer.

The Office further seeks to remedy Farkas's failure to teach or disclose adjusting the zeta potential of the metal surface during the removal of the barrier layer with Penniman's teaching. The Office cited Penniman's definition of zeta potential which is "an electrokinetic property of particles suspended in an aqueous medium containing charged ionic species and is an expression of the charge developed on or adjacent to such particles". The Office then concluded that the second CMP slurry of Farkas is deionized water based slurry containing charged ionic species and these charged ionic species in water have charges developed on or adjacent to such particles. Therefore, according to the Office, Farkas clearly describes a method by which zeta potential is created and the zeta potential of the metal surface during the removal of the barrier layer a functionally inherent step. Applicants respectfully submit to the Office that in order to establish the burden of proof of rejections based on inherency, "the examiner must provide a basis in fact and/or technical reasoning to reasonably support the determination that the allegedly inherent characteristics necessarily flows from the teaching of the prior art." *In Ex parte Levy*, 17 USPQ2d 1461, 1464. The two-step CMP process of Farkas was designed to reduce the problem of dishing, specifically in a copper interconnect with a tantalum-based barrier layer. There is nowhere in the teaching of Farkas that one can derive from reducing dishing by using an ethylenediamine additive in conjunction with a specific polishing pad would modify the zeta potential of the metal layer in a way that carbon-rich particles are prevented from adhering onto the surface of the metal layer. A skilled person is therefore not taught that the slurries described in Farkas are necessary for modifying the zeta potential merely that any one of the slurries might create zeta potential. As stated *In re Spormann*, 363 F.2d 444, 150 USPQ 449, at 452, "the inherency of an advantage and its obviousness are entirely different questions. That which may

be inherent is not necessary known. Obviousness cannot be predicated on what is unknown.”
The feature of performing a second CMP process with a second slurry to remove the barrier layer and adjusting the zeta potential of the metal layer with a solution during the removal of the barrier layer can prevent particles of the low K dielectric material from adhering onto the surface of the metal layer is an unknown and thereby is not obvious.

In summary, the Office has provided unsupported conjecture for the motivation to combine. Applicants believe that the Examiner is arguing out of hindsight, finding pieces of the present invention within the prior art and assembling them according to the teaching of the present invention. Applicants further note that it is inappropriate hindsight to look back through Applicants’ disclosure and declare claim limitations obvious where such declaration can only be guided by Applicants’ disclosure.

In view of the foregoing, Applicants respectfully assert that the prior art cited by Examiner is legally deficient for the purpose of rendering claims 1 and 11 unpatentable. With regard to dependent claims 2-10, 21 and 12-18, 22 Applicants respectfully submit that these claims patently define over the prior art for at least the same reasons as independent claims 1 and 10. Withdrawal of the rejection and allowance of the application are earnestly requested.

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CONCLUSION

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For at least the foregoing reasons, it is believed that all pending claims 17, and 21-22 are in proper condition for allowance. If the Examiner believes that a telephone conference would expedite the examination of the above-identified patent application, the Examiner is invited to call the undersigned.

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Dated: Oct. 22, 2002

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